Applications of artificial intelligence in teaching mathematics for the second preparation year in Egyptian official language schools

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Abstract

The purpose of this study to assist educators and learners in addressing challenges and enhancing their teaching and learning outcomes is presented by technological advancements such as artificial intelligence (AI). Providing a thorough overview of AI in mathematics education for students at the second preparation year in Egyptian official language schools is the aim of this review, which aims to contribute to the discussion. Utilizing well-established and reliable guidelines, a systematic literature review (SLR) was carried out. Our search terms included Microsoft Math Solver (MMS), Math is Fun (MIF), Photomath, MathGPTPro and Mathway. As per the SLR findings, robots, systems, tools, teachable agents, autonomous agents, and a holistic approach were the methods employed by AI in mathematics education for the samples under investigation. Then, it becomes evident that the majority of the studies that were gathered were conducted in the USA and Mexico. According to the analysis, quantitative research methods were employed in the majority of the reviewed studies. The themes for artificial intelligence (AI) in mathematics education were divided into categories such as benefits and drawbacks, conceptual comprehension, factors, role, idea suggestion, strategies, and effectiveness.

Keywords: Artificial intelligence; Math is Fun; Photomath; Mathway; Symbolab; Microsoft Math Solver; MathGPTPro

1. Introduction

Applications of artificial intelligence (AI) in education are growing in popularity and have received a lot of attention lately. AI represents a breakthrough in original and creative thinking across a range of domains, including the teaching of mathematics. Artificial Intelligence (AI) has the potential to improve our ability to live in a world where technology is becoming more complex. According to Gao (2020), artificial intelligence (AI) is still growing and innovating due to advancements in computer technology. AI helps students acquire and improve more cognitive and mathematical learning skills [1].

MIF is a website provides resources for math teachers. There are numerous worksheets available for mathematics. A math dictionary and online games are also available on the website [2]. It also offers mathematics in an enjoyable and easy-to-learn manner, because it believes that

mathematics is fun [3]. The website is an excellent resource for students who might struggle to understand explanations provided in class or in textbooks because of its clear graphics and easy-to-use interface. Rod Pierce, DipCE BEng, the owner of Mathopolis, a quiz and game website, is the site's administrator. What exactly makes math fun, you might wonder? The reason is that it's one of the more reputable websites for math instruction that can benefit users of all ages. Let's begin with a brief note about the URL. Despite being called "Math Is Fun," the website's URL is MathsIsFun.com. The additional "s" is there because, as the website states near the bottom of the homepage, "math" is used in the U.S. and "s" is used in the U.K. Although it makes sense that the URL MIF.com redirects to the "maths" version, American users may initially perceive the page as having a suspect URL because of the extra "s" that appears after the redirect. When searching outside of university math department webpages, one of the primary math education websites that comes up is MIF. Users can rate websites through the Mathematical Association of America, and MIF receives an average score of 3.2 out of 5, with multiple ratings. The website serves as an addition to lectures and texts used in class. Those who are unfamiliar with a topic would benefit more from attending a math class and using the site as a secondary reference, even though someone reviewing procedures could use it alone. The goal of the website is to make math as approachable as possible. It might be useful for students organizing study groups outside of class or for parents who can go through the website's pages with their kids [4].

Photomath is an educational technology mobile app which is owned by Google. This app uses the camera on a smartphone to scan and identify mathematical equations, providing step-by-step explanations on the screen. It is a computer algebra system with an enhanced optical character recognition system [5]. Photomath is a smartphone application that provides a comprehensive solution for students who are struggling with math. The program, which uses cutting-edge AI technology, offers a fresh perspective on challenging mathematical problems and gives pupils a leg up on the competition. Photomath allows users to scan printed or handwritten math problems and get detailed, instantaneous solutions using their smartphone's camera. Students benefit from this in two ways: first, they gain insight into the problem-solving process, and second, they receive immediate feedback that helps them hone their mathematical abilities [6]. The application is built on a text recognition engine created by Microblink. Once the problem has been identified, the app will display solution steps, sometimes in a variety of methods or approaches, to explain the scanned problem step by step and teach users the proper procedure [7]. Photomath's main features are usually free of charge. Users can purchase an additional premium subscription for 'Photomath Plus', which includes functions such as mathematical word problems and working textbook solutions. Exclusive features like AI-powered animated tutorials, in-depth explanations, contextual hints, and personalized solutions for each problem in a variety of math textbooks—as well as word problem and geometry solutions that are highly sought after by users worldwide—are all unlocked with Photomath Plus [8].

Mathway lets the students get the resources they need from it to comprehend and resolve their math problems. With billions of problems resolved and millions of users, Mathway is the best resource for students, parents, and educators when it comes to problem solving. The long-term

objective of Mathway is to provide all children with high-quality on-demand arithmetic help. Over the coming years, Mathway is a long-term, ambitious creative project that will add more features and capabilities. Chegg's Mathway is an artificial intelligence (AI)-powered online math problem-solving platform that students of all skill levels may use for help with problems in algebra, calculus, trigonometry, and graphing. Mathway is an excellent resource for students who want assistance with their mathematical assignments because it utilizes artificial intelligence. Students can benefit from learning how to solve arithmetic problems by submitting problems and receiving detailed, step-by-step solutions. In addition, Mathway gives its customers a choice between a free edition with fewer features and a paid one with more advanced tools [6] and [9]. Mathway is not designed to only solve math equations, but it also explains the steps required to arrive at the correct answer. Students learning at home, people without access to a tutor, and even individuals who just want to double-check their math can all benefit greatly from this. In any event, math applications like the one we're looking at today are incredibly helpful resources for people who have trouble with arithmetic since they let students verify both their approach and their answers twice. Mathway is downloadable on iOS and Android platforms, while PC users are able to access a browser-based version of the app. Please be aware that access to the step-by-step breakdown requires a paid subscription [10].

Symbolab is a fantastic software for teaching arithmetic that uses artificial intelligence (AI) and offers a variety of functions for pupils. With the help of this online math solver program, kids may answer a variety of challenging math issues, including word problems, geometry, graphing, and more. For mathematicians of all ability levels, Symbolab is a helpful resource because of the wide variety of calculators it offers. It can assist children who struggle with arithmetic in developing greater self-assurance and comprehension of increasingly difficult subjects. Because of its many features and calculators, Symbolab is a great artificial intelligence (AI) tool for every learner who wants to perform well in mathematics. Symbolab's advanced AI-powered resources will come in handy for anyone studying for final exams in high school or pursuing a math-related degree in college [6]. The platform functions at the nexus of natural language processing, symbolic computation, and a thorough comprehension of mathematical concepts, all of which combine to produce a reliable and approachable math solver. It deciphers and streamlines user inquiries, solves difficulties using mathematical formulas and algorithms, and then offers thorough justifications for every stage of the procedure. Symbolab is a complex search engine designed especially for mathematical problems, not just an upscaled calculator. It uses a variety of computational methods and algorithms to decipher, streamline, and resolve a wide range of mathematical issues. Symbolab is based on a symbolic computation system, which is also referred to as computer algebra or symbolic algebra. With this method, the search engine can work with mathematical equations symbolically, which means that variables and equations don't always need to have explicit numerical values in order for it to understand and function. Apart from producing answers, the platform also offers detailed explanations of its methodology. This feature is especially helpful for students who want to know how to solve complicated situations. Giving users the procedure rather than just the solution gives them a more pedagogical viewpoint, enabling them to see where they might have made a mistake and

learn how to approach similar issues in the future. Symbolab provides a premium subscription in addition to a free version. The solver is available in the free edition, albeit there aren't as many step-by-step solutions. On the other hand, the premium edition offers more practice problems, limitless step-by-step solutions, and ad-free usage. When Symbolab is used as a crutch to avoid learning rather than as a tool to aid in comprehension, there is a risk for overuse. Even if it's an effective tool for giving detailed answers to tricky mathematical problems, students run the risk of relying too much on it to supply the answers, particularly when presented with difficult assignments or short deadlines [11].

Microsoft Math Solver (previously Microsoft Mathematics and Microsoft Math), solves math and science problems. This entry-level educational program is a learning tool primarily intended for students and is developed and maintained by Microsoft. It was Microsoft Windows-based till 2015. It has subsequently been adapted for mobile and web platforms. Microsoft's AI-based Math Solver is an approachable tool for resolving challenging arithmetic problems. Users can enter equations and receive comprehensive solutions as they go because to its user-friendly interface. The tool's identification capabilities are so sophisticated that it can recognize poorly written symbols with accuracy. For both beginner and expert users, Microsoft Math Solver also offers interactive images and practice problems. Microsoft Math includes features aimed for educating users and helping with problem solving in science, math, and technology. Tools like a unit converter and a graphing calculator are included in the application. In addition, it has an equation solver and a triangle solver that offer detailed answers to every issue [6] and [12].

MathGPTPro is an AI tool that blends mathematical problem-solving skills with artificial intelligence. It provides users with access to an advanced mathematics problem solver and is made to facilitate the solving of difficult mathematical problems. Users may easily answer challenging arithmetic problems with MathGPTPro. MathGPTPro is an artificial intelligence tool for solving mathematical puzzles. MathGPTPro's advanced capabilities can be quickly accessed by users with its simple sign-up and login options. This tool is designed for anyone dealing with complex mathematical problems. Users can solve a variety of mathematical problems much faster by using MathGPTPro. For a wide range of mathematical tasks, MathGPTPro provides a thorough solution, from simple computations to intricate equations. Whether you are a professional, researcher, or student, this tool can help you solve difficult mathematical problems. Through the tool's user-friendly interface, users may access and sign in to their MathGPTPro accounts. Users have the option to proceed as guests or log in using their email address and password. There is a way to retrieve or modify their password in case they forget it. with a specific focus on advanced mathematics, MathGPTPro provides a wealth of features to help users with a variety of mathematical difficulties. By giving users the assistance, they require to navigate challenging mathematical ideas and come up with precise solutions, this application seeks to improve users' problem-solving skills in advanced mathematics. All things considered, MathGPTPro is a useful AI tool for anyone working in advanced mathematics since it offers a platform that combines artificial intelligence with the ability to solve mathematical problems [13] and [14].

2. Methodology

2.1 MMS

MMS is a tool that helps users solve mathematical problems using a combination of artificial intelligence and mathematical algorithms. MMS uses image recognition to interpret mathematical problems. Users can take pictures of handwritten or printed math expressions using a camera or upload images from their device [15]. (See **Fig. 1**)

Fig.1: Represents that we can type a math problem, and then click on Solve, the program will solve this math problem in steps.

With MMS, users can explore content relevant to the original math problem and see solutions to arithmetic equations. From pre-algebra to calculus, the app covers a wide range of math topics and frequently offers multiple approaches to solving an issue. Instead of needing to know the name of the skill or vocabulary, users can type, draw, or scan an issue to receive a solution and comprehensive step-by-step instructions. (See **Fig. 2**).

To enhance the learning experience, MMS may generate step-by-step solutions. This feature helps users understand the problem-solving process by providing detailed explanations and intermediate steps [16]. (See **Fig. 3**)

On tablets as well as phones, writing and scanning functions are equally dependable. The application also has a web version. A web search returns answers along with a list of Khan Academy videos covering the same or similar topics. (See **Fig. 5**)

Worksheets and comparable problems are available for honing skills linked to the answer. Following the solution, users can create a quiz on the subject. Additionally, users can test their knowledge and practice abilities by visiting the daily quiz section. The app's history contains quiz scores, previously searched questions, and quiz results for convenient reference [17]. (See **Fig. 6**)

Fig. 2: Represents the math topics in MMS.

MMS is a good study aid for self-directed students who already possess a solid understanding of algebraic language and who are driven to investigate solutions rather than just quickly find the solution. The fact that MMS provides a variety of learning modalities and incentives, such as interactive graphs, worksheets, quizzes, and movies, is a wonderful touch. With the help of these

resources, motivated students should be able to better understand the concepts and skills behind the problem they're having trouble with. Teachers will need to verify that students have understood the material because some won't go that far. However, there is a noticeable emphasis on providing excellent language help, immersive reader support, and scanning/drawing choices for ingesting difficulties to cater to a broad range of learners. Additionally, certain functionality is either absent or not functioning properly. For example, word problems cannot be scanned by the app. To provide support, an equation is needed. We also encountered problems when creating tests using the answers. Sometimes that feature was unable to produce any quizzes at all. Additionally, there aren't any cues or supports to push students to find a solution. It appears that scanning an equation and launching an educational experience that helps someone arrive at an answer on their own is the next logical step for these kinds of apps [17]. path if there isn't any supervision or check-ins [17].

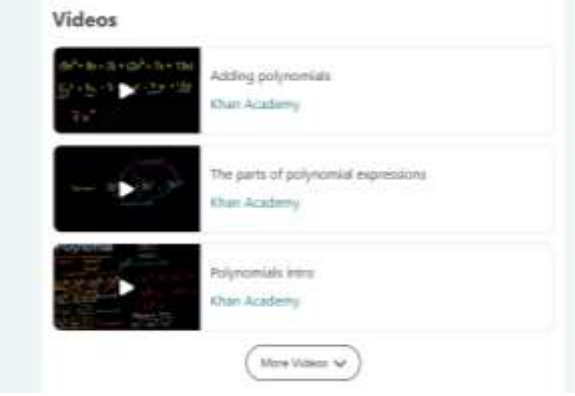


Fig. 4: Represents videos explain similar problems.

Fig. 3: Represents a factorization problem and its solution in step-by-step.

Students working independently through math problems can benefit from some instructional moments brought home by using MMS. To help them acquire the skill and make up for missing class or power through homework, students can quickly scan a problem and then select to watch a video or view a solution. Students' instinctive leaps forward have a place to land thanks to the Microsoft Math Solver. For solitary study or in a flipped classroom, this app and others that offer solutions to math problems can be very beneficial. Be cautious, though, as not all of the search results closely match the talent. Students can be taking the incorrect

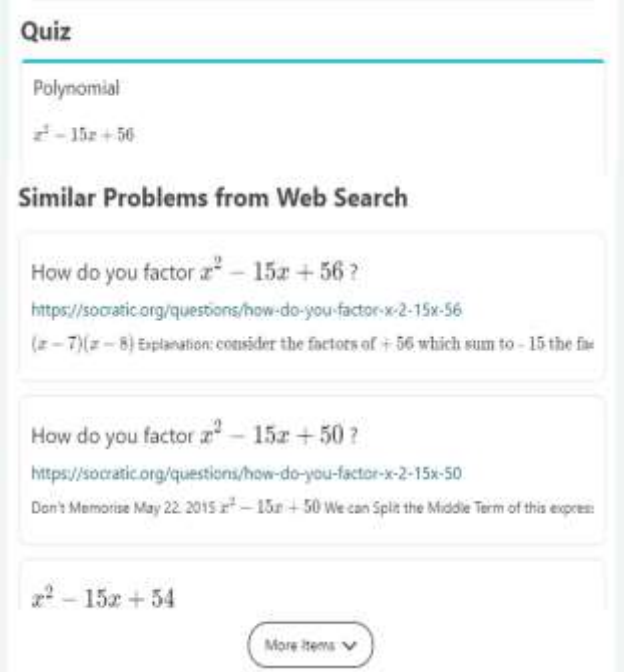


Fig. 5: MMS contains quizzes.

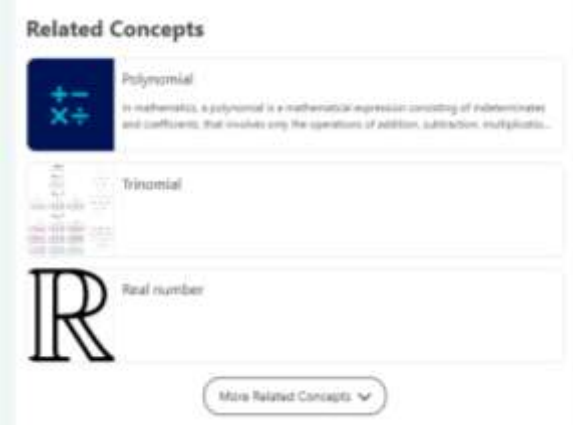


Fig. 6: Illustrates that MMS supports related concepts in mathematics.

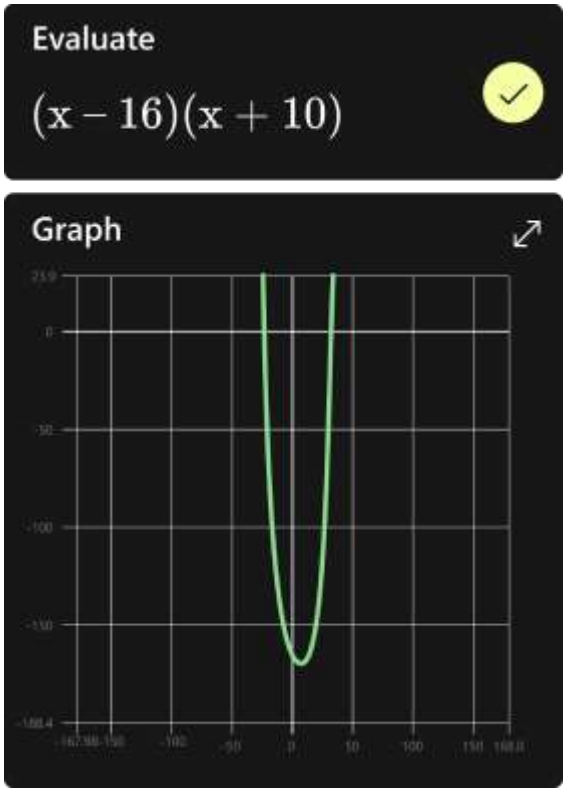


Fig. 7: Quickly graph any equation to see your function and understand how variables are related.

2.2 MIF

MIF is available to parents and students via any web browser. It offers online math lessons, practice problems (both on-site and hosted on other websites), and a wealth of additional math resources, including a glossary of math terms, a variety of calculators and tools, printable worksheets, and even some fascinating physics subjects for students to investigate. The essential information and content of the website are prominently placed in the center of the page, and there aren't many extraneous items around the edges or sides of the page, making the website itself look really tidy and uncluttered. For younger kids and independent learners, this can be a huge benefit because it means that using the site itself isn't as distracting. Parents and students can also find study topics in a variety of ways,

which is always beneficial. On the home page, for instance, there are numerous buttons and icons that are placed prominently. These are arranged thematically and offer easy access to a number of more general math concepts (money, numbers, data, geometry, measurement, and calculus), along with some learning and practice aids (worksheets, activities, puzzles, games, and so on) [18].

MIF offers parents a great deal of flexibility in terms of finding resources and planning their studies. Depending on the needs of the family, this flexibility allows the site to be used for both immediate review and practice as well as a more in-depth, long-term curriculum supplement. However, some alternatives (like its "Curriculum" or "Common Core Standards" sections) aren't always clear from the front page or available from their primary navigational menu, so sometimes you have to click around the site to locate what you're looking for. The text is also mixed with useful images, boxes, charts, diagrams, the occasional playable animation, and even the rare interactive element, such as the number line shown below, which moves from side to side when hovered over with a mouse [18].

MIF offers a variety of math-related puzzles and games in addition to practice questions and worksheets that can assist students in honing their skills without requiring as much computation. The puzzles, which consist of a series of word problems, activities, and brainteasers on a screen, are designed to push students' general reasoning and critical thinking abilities while directly challenging them in a number of math concepts, such as algebra, geometry, and measurement. There are generally many different kinds of puzzles to deal with; some are more immediately and openly tied to particular concepts, while others present a challenge to students in terms of how to approach and solve them completely [18].

Students can also play a few games on Math Is Fun's website. Compared to worksheets and exercises, these games—many of which are clearly math-related—allow students to practice and test their arithmetic skills in a little more enjoyable way. For instance, in the memory-style game Math Match, players must turn over cards to show either an equation or an answer. Students must, of course, match the correct answer to the equation in order to win. It's vital to remember that not every game has a math-related theme; many of them are just variations of classic internet games like battleship, chess, checkers, four in a line, tanks, and balloon pop. Although these can be a pleasant diversion from homework and practice, parents should watch out that their children aren't becoming overly engrossed because the website has no real restrictions on how much time pupils can spend playing. Furthermore, even while they can be entertaining, the games are somewhat basic and archaic when contrasted with the more sophisticated games and richer animations available on several rival pay websites. Although they can serve as a pleasant diversion or incentive, younger kids who have grown up with the newest 3D games are unlikely to find them particularly captivating or impressive. We do like that a lot of the games are now accessible in HTML5, as opposed to previously being based on Flash animation, as this should enable them to be played on a wider range of contemporary devices [18].

Fig .8: Represents that MIF supports many math topics.

Fig. 9: Represents an explanation of Math in easy language.

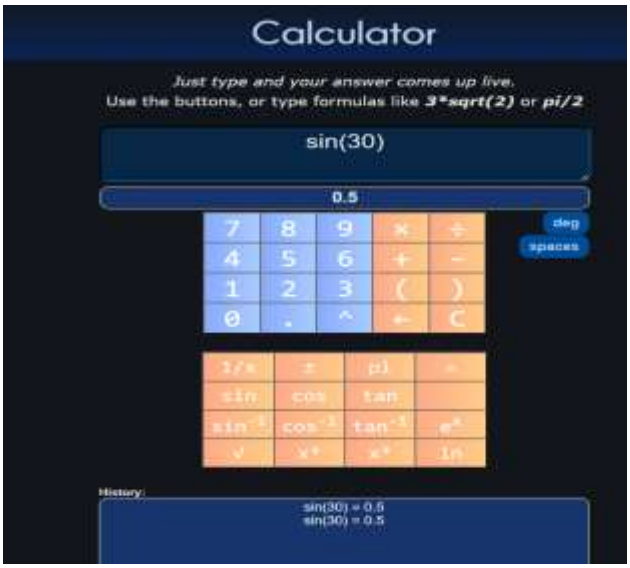


Fig. 10: Illustrates that MIF contains a calculator.

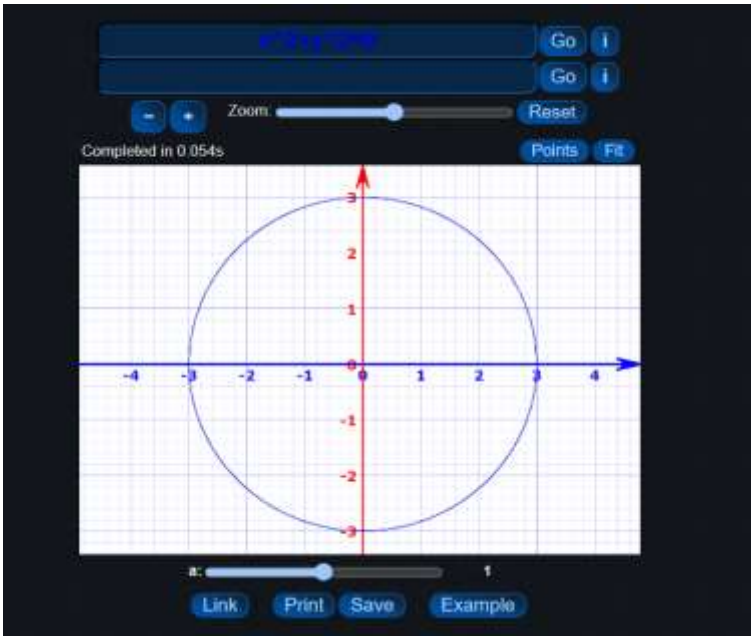


Fig. 11: Represents that MIF contains an equation graph.

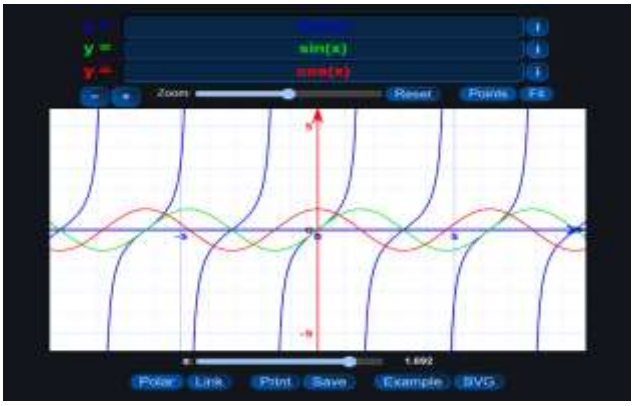


Fig. 12: Represents that MIF contains a function graph.

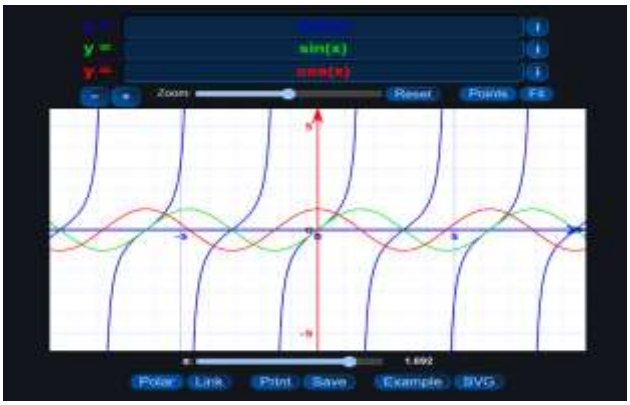


Fig. 12: Represents that MIF contains a function graph.

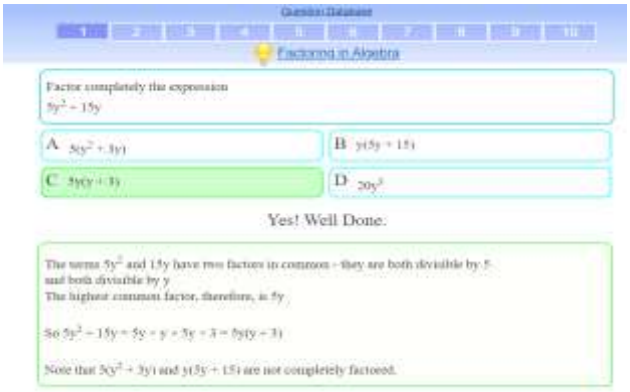


Fig. 13: Represents that MIF contains quizzes.

Fig. 14

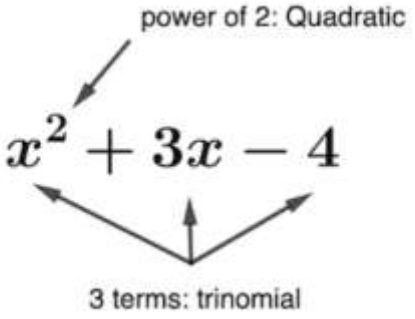
Fig. 15

Fig. 14 and Fig. 15 represent some examples of games.

3. Results and Discussion

3.1 Results of MMS

Factorizing quadratic trinomial in the form: $x^2 + bx + c = 0$



MMS can solve a wide range of mathematical problems by different ways, It serves as an educational tool, helping users understand the steps involved in solving complex math problems.

MMS offers several advantages

Step-by-Step answers: One of MMS's main features is the provision of step-by-step answers to mathematical issues. When users enter their difficulties, the program provides a comprehensive solution that breaks down each step needed to arrive at the solution. This feature aids users in comprehending the reasoning and process involved in resolving different kinds of mathematical issues.

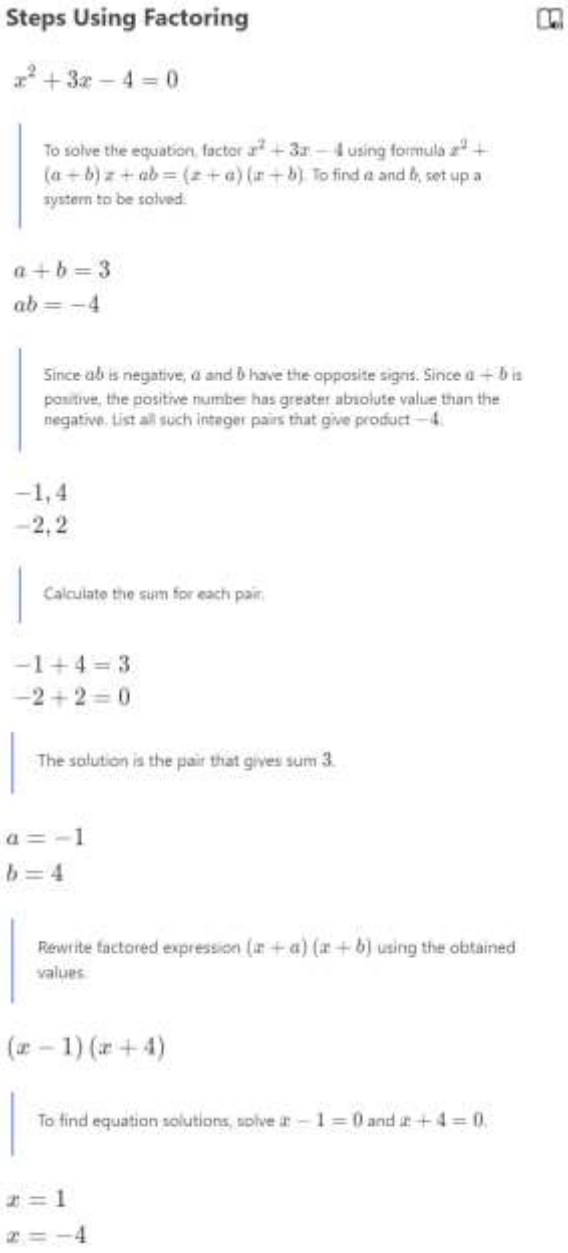


Fig. 16: represents the solution step by step.

Graphing Function: Users can see mathematical equations and functions by using the graphing function included in the MMS. This tool is very useful for comprehending algebraic, calculus, and geometric ideas. Through graphical representation, users can plot functions, investigate their behavior, and learn more about mathematical relationships.

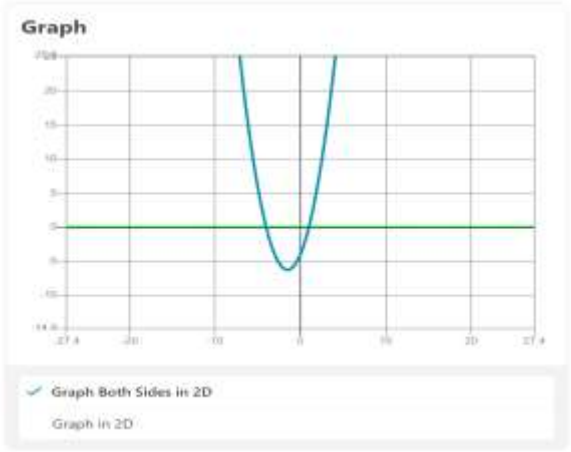


Fig. 17: represents Graphing Function.

Interactive Learning tools: MMS provides interactive learning tools like practice problems, interactive graphs, and video tutorials in addition to solutions. These tools support learning, deepen comprehension of mathematical ideas, and enhance problem-solving abilities as shown in this video. **https://drive.google.com/file/d/1ZH2hhCTnPiO78q_fsvsLq5RsnRc3nGTi/view?usp=drive_link**

Range of Input types: The application may accept a number of input types, such as typed equations, handwritten notes, and photos of math problems. Because of its adaptability, users can input their concerns and obtain support more easily because it takes into account a variety of user preferences and conditions.

Fig. 18: represents that the application may accept a number of input types, such as typed equations.

Instructional Materials: MMS offers instructional materials on a range of mathematical subjects, such as concept definitions, examples, and explanations. Beyond merely solving particular problems, this tool helps users gain a deeper understanding of mathematical concepts and principles.

Fig. 19: represents that the application contains particular problems.

3.2 Results of MIF

MIF offers several advantages

Interactive courses: From elementary arithmetic to advanced calculus, the website provides interactive courses covering a wide range of mathematical topics. To aid users in understanding subjects more fully, these classes frequently incorporate interactive exercises, animations, and visual aids.

Reference Material: With definitions, explanations, and examples for a wide range of mathematical terms, concepts, and formulas, the website acts as a thorough reference resource for mathematics. This helps consumers comprehend mathematical ideas and use them to solve problems.

Worksheets and Printables: To help with math practice, MIF provides a variety of downloadable worksheets and quizzes.

(See **Fig. 21**)

These worksheets allow users to practice skills and reinforce their learning across a range of topics and difficulty levels.

Tools and Calculators: To help users with computations and problem-solving, the website offers a variety of math tools and calculators. These resources are beneficial to both professionals and students because they address a variety of mathematical activities, such as arithmetic, algebra, geometry, and more. (See **Fig. 10, 11 and 12**).

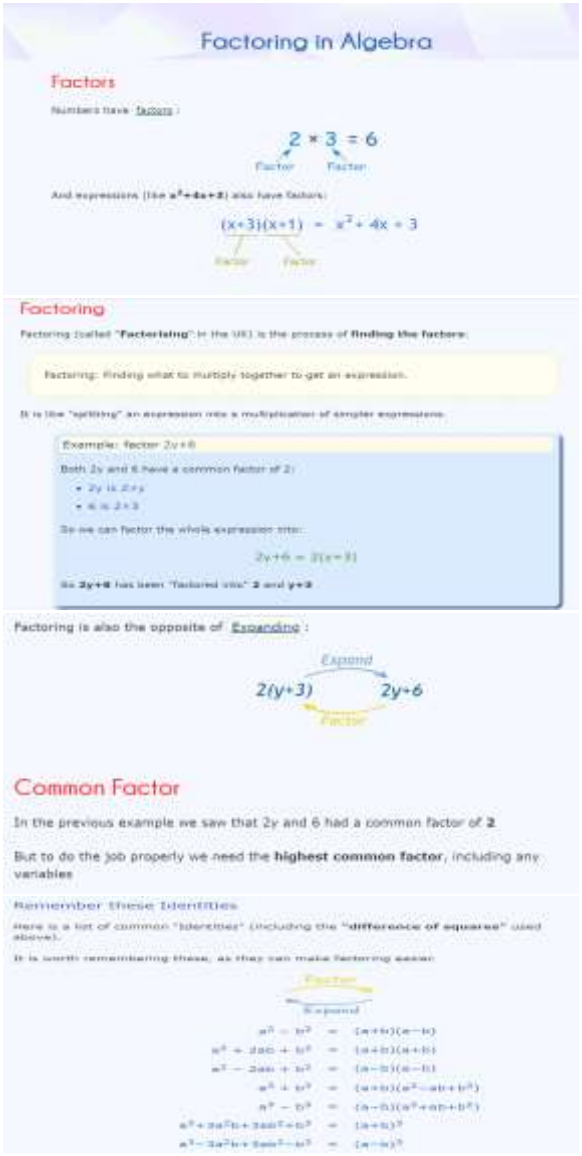


Fig. 20: Represents lesson explanation.

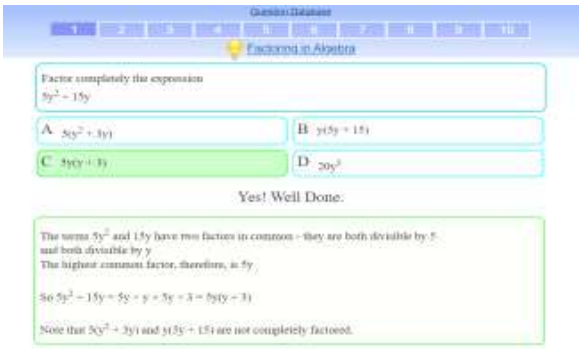


Fig. 21: Represents that MIF contains quizzes allow users to practice.

3.3 Application on Using MIF and MMS For the Second Preparation Students

In Math is Fun (MIF), we used "Fireworks Counting" game designed to help students practice counting skills in a fun and interactive way. In the game, students are presented with a scene filled with fireworks of various colors and sizes. The objective is to count the number of fireworks displayed on the screen within a given time limit. As they count the fireworks, they can click on each firework to keep track of their progress. The game encourages quick and accurate counting, helping students improve their numeracy skills while enjoying the colorful fireworks display. It's a playful way to reinforce counting abilities and develop number sense. After that, we played "The Broken Calculator" game that challenges players to reach a target number using a limited-functionality calculator with broken or missing buttons. Players must strategically use available operations and numbers to achieve the target, enhancing mathematical reasoning and problem-solving skills as shown in this video.

https://www.mediafire.com/file/dkfjis1coiscqp2/2.mp4/file

In Math is Fun (MIF), we had played "4 In A Line!" game which is built on HTML5 with the students to enhance pattern recognition, combinatorics, probability understanding, spatial reasoning, game theory concepts, logical thinking, arithmetic skills, and graph theory insights. Through gameplay, students can develop and reinforce these mathematical skills in an engaging and interactive manner. Then, we used the dictionary that provides explanations and definitions of mathematical concepts in a clear and accessible manner. It covers a wide range of topics from basic arithmetic to advanced calculus, making math more understandable and enjoyable for learners of all levels. The dictionary offers explanations, examples, and illustrations to help users grasp mathematical concepts effectively as shown in this video.

https://www.mediafire.com/file/57umjpokxoe99nj/1.mp4/file

We discussed about Microsoft Math Solver (MMS) which is an educational tool offering step-by-step solutions to math problems, a graphing calculator, interactive learning features, video explanations, cross-platform accessibility, integration with Microsoft products, and multilingual support as shown in this video.

https://www.mediafire.com/file/7p6tn0xapg0an8g/4.mp4/file

In Microsoft Math Solver (MMS), we showed the students a video explaining the matrices lesson and this explain that Microsoft Math Solver's video explanation feature is a valuable tool for students and

learners of all levels, providing additional support and guidance in understanding math concepts and problem-solving techniques as shown in this video.

https://www.mediafire.com/file/lc94zsnt2cst4f0/3.mp4/file

Table1: A statistical result about the opinions of a sample of 60 students when they use both MMS and MIF applications

Sample	MMS	MIF	Percentage		Reasons for preference
60 students			MMS	MIF	
Prefer	**18**	**42**	**30%**	**70%**	**18 students believe that Microsoft Math Solver is better than Math is Fun, as Microsoft Math Solver solves problems and equations in simple and easy steps.**
Not prefer	**42**	**18**	**70%**	**30%**	**42 students found Math is Fun is better than Microsoft Math Solver in terms of various games and puzzles that rely on intelligence and intuitive speed. Math is Fun also explains the lessons and examples in a simpler way, which makes this site really fun.**

4. Conclusions

This research studies Artificial intelligence (AI) applications in education, particularly in mathematics teaching, are gaining traction due to their potential to

enhance cognitive skills. Gao (2020) notes AI's ongoing growth, driven by advancements in computer technology, aiding in cognitive and mathematical learning. Websites like MIF and MMS offer resources, games, and clear explanations to make math enjoyable and accessible for students of all ages. Photomath, owned by Google, revolutionizes math learning by using AI to provide step-by-step explanations via smartphone camera scans. Mathway, powered by Chegg, offers AI-driven problem-solving for various math subjects, aiding students in understanding and solving equations. Symbolab, employing AI, provides step-by-step solutions and explanations for complex math problems, promoting comprehension and self-confidence. Microsoft Math Solver, developed by Microsoft, offers comprehensive solutions with interactive images and practice problems. MathGPTPro integrates AI with advanced mathematical problem-solving capabilities, catering to users tackling complex math challenges. These AI-driven tools aim to enhance mathematical learning and problem-solving skills across different levels of expertise and educational settings, offering accessible and efficient solutions for students, educators, and enthusiasts alike.

In conclusion, the increasing utilization of artificial intelligence (AI) in education, particularly in mathematics instruction, presents promising avenues for enhancing learning outcomes and cognitive skills. The research highlights the diverse applications of AI-driven tools such as Photomath, Mathway, Symbolab, Microsoft Math Solver, and MathGPTPro which offer step-by-step solutions, interactive features, and comprehensive explanations to aid students in understanding and solving mathematical problems. Moreover, websites like Microsoft Math Solver (MMS) and Math is Fun (MIF) contribute to making math enjoyable and accessible through engaging resources and clear explanations. These AI-powered platforms have the potential to address the diverse needs of students, educators, and enthusiasts by providing personalized learning experiences, immediate feedback, and supplementary resources. However, while AI holds great promise for improving mathematical learning, there is a need for further research to explore its long-term impact, effectiveness in diverse educational settings, and potential challenges such as overreliance on technology. Overall, the findings underscore the importance of leveraging AI technologies to foster mathematical proficiency and enhance educational outcomes in the digital age.

Acknowledgement

We’re writing to express our sincere gratitude to Dr. Mona Abdelhamid for her outstanding and continuous efforts as our supervisor on our graduation project titled "Applications of artificial intelligence in teaching mathematics for the second preparation year in Egyptian official language schools". The journey of graduation with you has truly been an enjoyable and fruitful experience, as you have guided and supported us exceptionally throughout this period. We would also like to express our special thanks to Dr. Safaa Shehata, the Dean of the Faculty of Education – Ain Shams University, for her support and encouragement throughout our studies. Her presence as a leader in the college and her continuous support had a significant impact on motivating and encouraging us to achieve success.

References

1. Gao, S. (2020). Innovative teaching of integration of artificial intelligence and university mathematics in big data environment. IOP Conference Series: Materials Science and Engineering, 750(1), 012137. https://doi.org/10.1088/1757-899X/750/1/012137
2. Math Is Fun.com | The Power of Discovery. (n.d.). Retrieved from: https://powerofdiscovery.org/math-funcom
3. About Math is Fun. (n.d.). Retrieved from https://www.mathsisfun.com/aboutmathsisfun.html
4. What is Math is Fun? - Classful. (n.d.). Retrieved from: https://classful.com/what-is-math-is-fun/
5. Wiggers, Kyle (18 February 2021). "AI-powered math tutoring app Photomath raises $23 million". VentureBeat. Archived from the original on 24 June 2021. Retrieved from: https://venturebeat.com/business/ai-powered-math-tutoring-app-photomath-raises-23-million/
6. 15 AI-based Math Tools. AI Tools Club. Retrieved from: https://www.aitoolsclub.com/15-ai-based-math-tools/
7. TechCrunch is part of the Yahoo family of brands. (2014, October 20). Retrieved from: https://techcrunch.com/2014/10/20/microblink-launches-photomath-to-solve-math-equations-with-a-phone/
8. Photomath Plus overview - Photomath Help. (n.d.). Retrieved from: https://support.google.com/photomath/answer/14330572?hl=en&ref_topic=14328036#zippy=%2Cwhat-is-photomath-plus%2Chow-is-photomath-plus-billed
9. Mathway | About Us. (n.d.). Retrieved from: https://www.mathway.com/en/about
10. How to: Use Mathway (a problem-solving app). Neil Squire Society. Retrieved from: https://www.neilsquire.ca/how-to-use-mathway-a-problem-solving-app/
11. A. (2023, May 14). The Responsible Use of Symbolab: Balancing Aid and Autonomy in Learning Mathematics. AdmissionSight. Retrieved from: https://admissionsight.com/the-responsible-use-of-symbolab/
12. Microsoft Math Solver. (2023, May 28). Wikipedia. Retrieved from: https://en.wikipedia.org/wiki/Microsoft_Math_Solver
13. MathGPTPro – GENAI. (n.d.). Retrieved from: https://genai.works/app/mathgptpro/
14. MathGPTPro. (n.d.). Retrieved from: https://topai.tools/t/mathgptpro
15. Chellapilla, K., & Simard, P. (2004). High performance convolutional neural networks for document processing. In Tenth International Workshop on Frontiers in Handwriting Recognition (pp. 33-38). IEEE. https://www.researchgate.net/publication/228344387_High_Performance_Convolutional_Neural_Networks_for_Document_Processing
16. Mamona-Downs, J., & Downes, T. (2005). Reusable Learning Objects

and Their Role in Enhancing Online Learning Environments. In Handbook of Research on Hybrid Learning Models: Advanced Tools, Technologies, and Applications (pp. 258-272). IGI Global. http://dx.doi.org/10.1108/IJEM-12-2019-0418

17. Microsoft Math Solver Review for Teachers | Common Sense Education. (2023, December 12). Common Sense Education. Retrieved from: https://www.commonsense.org/education/reviews/microsoft-math-solver
18. Math Is Fun Review. (n.d.). The Smarter Learning Guide. Retrieved from: https://smarterlearningguide.com/math-is-fun-review/